January 8, 2002

SUPPLEMENTAL SPECIFICATION

SECTION 13594

FIBER OPTIC COMMUNICATION

Add this Supplemental Specification to the Standard Specifications.

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnish, install, and test communication system.

1.2 REFERENCES

A. ASTM A615, Grade 60.

B. Bellcore Testing Requirements GR-771-CORE.

C. EIA/TIA-455-82B: Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable (ANSI/EIA/TIA-455-82B-92).

D. NEC 250-1: National Electric Code Grounding.

E. Telcordia GR20-CORE: Optical Fiber and Optical Fiber Cable.

F. Telcordia GR-771: Fiber Optic Splice Enclosure.

G. TIA/EIA-4720000-A: General Specification for Fiber Optic Cable (ANSI/TIA/EIA-4720000-A-93).

H. TIA/EIA-598-A: Optical Fiber Cable Color Coding (ANSI/TIA/EIA-598-A-95).

I. USDA Rural Electrification Administration (REA) specification for filled fiber optic cables (PE-90).

1.3 RELATED SECTIONS

A. Section 13553: ATMS Conduit.

B. Section 13554: Polymer Concrete Junction Box.

C. Section 13555: ATMS Cabinet.

1.4 DEFINITIONS

A. OTDR: Optical Time Domain Reflectometer

B. OSP: Outside Plant

1.5 SUBMITTALS

A. Evidence of training and experience for fiber optic staff. Include in the file for each technician a resume listing relevant education and experience, and a certificate of completion for the fiber optic training course.

B. For approval:

1. A detailed construction and installation procedure covering all aspects for the fiber optic cable installation on this project.

2. All materials for the fiber optic cable installation on this project.

3. Fiber labeling setup.

C. Prior to the splicing of any fiber cable, submit to the Engineer the part number and manufacturer of the cleave tool along with an "end angle" distribution chart which demonstrates the actual 150 cut end angles.

D. Submit to the Department and maintain on file a current calibration certificate for the OTDR being used.

E. Submit OTDR test results to the Department in a neatly bound and printed format for acceptance. Electronic submittal to Engineer on floppy disk or CD is also required.

F. Submit Power Meter/Light Source Test results to the Department for acceptance (Fiber Optic Continuity Test Form).

1.6 ACCEPTANCE TESTING

A. Contact the Engineer 48 hours prior to performing all acceptance testing (Post Termination and Splicing OTDR and Power Meter).

B. Perform all fiber optic testing with an OTDR capable of producing output files compatible with the Siecor OTDR 383PCW Version 1.21 or higher.

C. After completing the required work, use an OTDR to test one strand per buffer tube randomly selected by the Inspector. Conduct the test for each and every buffer tube running through the splice closure.

D. If the OTDR trace for any randomly selected strand shows evidence of damage, OTDR test each and every strand passing through the splice enclosure.

E. Repair any damaged fiber strands using fusion splicing methods and repeat all tests described below.

F. OTDR Testing Requirements

1. After completing the required work, test every fiber strand passing through any splice tray that was opened by the Contractor.
2. Conduct all traces with a pigtail or fiber box between the OTDR and the fiber under test.
3. Maintain minimum length of the fiber in the fiber box greater than the dead zone specified by the manufacturer.
4. Do not exceed launch transition of 6 dB.
5. Conduct all traces at both 1310 nm and 1550 nm.
6. Unless otherwise noted, unidirectional traces are acceptable.
7. Bidirectional averaging may be used when apparent splice losses are being impacted by core offset or other factors.
8. Provide traces with the following information:
    a. Horizontal Axis: Distance in Kilometers.
    b. Vertical Axis: attenuation scale in dB.
    c. Traces showing attenuation versus distance.
    d. Cursors positioned at cable ends.

9. Tabulate for each trace: method, fiber type, wavelength, pulse width, refraction index, range, search threshold, reflection threshold, end threshold, warning threshold, backscatter, jumper length, file date, file time, fiber ID, cable ID, OTDR location, far end location, operator initials.
10. Provide an event table showing all events having more than 0.05 dB loss, containing event type, position from OTDR end, loss and reflectance.
11. For cables less than 1 km in length, the maximum total allowable attenuation is 1.0 dB.
12. Identify fibers by strand number.
13. Submit results in printed form on 8 ½ x 11 paper in a suitable binder organized by cable and strand number.
14. A cover sheet is required for each binder indicating which cable(s) were tested, the OTDR users name, the reviewers name, the type of test performed and the date(s) of the test.
15. Cover sheets for final test results bearing the reviewers signature, the date, and a statement indicating that the installation complies with the requirements of this section is required.
16. The Contractor's employee who has reviewed the traces is required to sign or initial them. A check mark is required on all traces that satisfy the requirements identified herein. For intermediate test results, flag any discrepancies which may exist with a short description of the proposed corrective action. (e.g. resplice).
17. Submit to the Engineer on 3 ½ inch floppy disk or CD electronic media with a printed index.

G. Post Termination and Splicing Test

1. Test every strand in all cable segments including connectorized strands of drop cables.
2. Light Frequency: 1310 nm and 1550 nm.
3. Direction: Unidirectional.
4. Location of test: Every field location required to obtain access to each cable segment.
5. Test after terminating and splicing at all points shown on the plans.
6. Cable Tested by: Certified Contractor Staff.
7. Department inspector witnesses and approves before final approval by the Engineer.
8. Acceptance Criteria:
    a. Cable attenuation # 0.4 dB/km at 1310 nm excluding splices shown on the plans or authorized by the Engineer.

b. Cable attenuation # 0.25 dB/km at 1550 nm excluding splices shown on the plans or authorized by the Engineer.
c. Strand lengths are consistent.
d. Launch Transition < 6 dB.
e. No event > 0.30 dB**.**
f. Maximum splice attenuation 0.20 dB per splice unless otherwise shown on the plans.

9. Trace available for each strand in all cable segments.

H. Power Meter Test

1. Connect the light source to the connectorized fiber at the location identified on the Fiber Optic Test form. Connect a power meter to the other end of the fiber at the location identified on the Fiber Optic Test form.
2. Turn on the light meter and record the power received at the power meter in the appropriate location on the Fiber Optic Test form.
3. Specifically indicate the fibers tested on Fiber Optic Test form. Otherwise, test each strand in every cable segment including connectorized strands of drop cables.
4. Use the light frequencies of 1310 nm and 1550 nm, or as indicated in test plans.
5. Perform the test uni-directional.
6. Test every field location required to obtain access to each cable segment.
7. A qualified member of the Contractor staff will perform all testing.
8. A Department inspector witnesses and approves the results before final approval by the Engineer.
9. Acceptance Criteria:
   a. Cable attenuation as called for in test plans.
   b. Strand lengths are consistent.
   c. Launch Transition less than 6 dB.
   d. No event less than 0.30 dB.
   e. Maximum splice attenuation 0.20 dB per splice unless otherwise shown on the plans.
   f. Trace is available for each strand indicated in test plans. Otherwise, trace will be available for each strand in each cable segment.

I. Light Source Test

1. Connect the light source to the connectorized fiber number at the location identified in the Fiber Optic Test Forms. Connect a power meter to the other end of the fiber at the location identified in the Fiber Optic Test Forms.
2. Testing:
   a. Turn the light source off and on at a rate of approximately once per second for three cycles. Observe the power meter and record the response of the meter in the appropriate location on the Fiber Optic Continuity Test form.
   b. Indicate OK if the Contractor notes the meter responding to each of the three cycles. Indicate BAD for any other responses, such as no cycles, less than three cycles, or more than three cycles.
   c. For each bad response, submit to the Engineer a statement summarizing the response.
   d. A tone modulated light source may be used, in place of the three cycle method, to conduct this test.

J. Fiber Optic Continuity Test Form

1. Complete the ATMS Fiber Optic Continuity Test Form included at the end of this Section and submit the completed form to the Engineer. This form identifies the specific set up location for the power meter and light source.
2. Connect the light source to the connectorized fiber number at the location identified in the ATMS Fiber Optic Continuity Test Form. Connect a power meter to the other end of the fiber at the location identified in the ATMS Fiber Optic Continuity Test Form.
3. Turn on the light meter and record the power received at the power meter in the appropriate location on the ATMS Fiber Optic Continuity Test Form.
4. The Fiber Optic Continuity Test Form identifies the specific set up location for the power meter and light source.

K. Perform all work to conform to the National Electric Code.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials are UL listed.

B. Provide all incidental materials including but not limited to fiber optic jumpers, cable ties, labels, data cables, and connectors.

2.2 FIBER OPTIC CABLE

A. Contact the Engineer for approval of fiber that is to be used.

B. The fiber optic cable is an Outside Plant (OSP) type, nonarmored dielectric loose tube, single mode cable.

C. Packing and Shipping (OSP Cable):

1. Ship the cable wound on spools or reels.
    a. Pack only one continuous length of cable per spool.
    b. Package the cable to prevent damage during shipping and handling.
2. When a length of cable's weight exceeds 363 kg, a large wooden reel with wooden staves is required.
    a. Cover the cable with a thermal wrap.
    b. Secure the outer end of the cable to the reel head to prevent the cable from becoming loose in transit.
    c. Project the inner end of the cable a minimum of 2 m into a slot in the side of the reel or into a housing on the inner slot of the drum, in such a manner to make it available for testing.
    d. Arbor hole: 40 mm minimum.
3. Test tails: at least 2 m long.
    a. Fasten the inner end to prevent the cable from becoming loose during shipping and installation.
    b. Apply end seals to each end of the cable to prevent moisture from entering the cable.
4. Mark each reel with an identification number that can be used by the manufacturer to trace the manufacturing history of the cable and the fiber.
5. Mark each reel to indicate the direction in which it should be rolled to prevent loosening of the cable on the reel.

6. Include the manufacturer's test documentation with each reel. This documentation indicates the attenuation of each cable fiber in dB/km, measured at 1310 nm and 1550 nm for single mode.

D. Outside Plant (OSP) Single Mode
General Characteristics:

1. Each OSP cable is of one type with the following features: all dielectric, loose tube, conforming to PE90 outside plant cable.
2. Provide all fiber optic cable on this project from only one manufacturer who is regularly engaged in the production of this material.
3. Fiber cables:
   a. all one mode (single or multimode),
   b. single mode and multimode under one sheath construction (HYBRID CABLE), or
   c. optical fiber/copper combination (COMPOSITE).
4. Install single mode fiber optic cable for the fiber optic communication system. The fiber cable conforms to the following:
   a. Latest version of Telcordia Technologies GR20-CORE: Generic Requirement for Optical Fiber and Optical Fiber Cables;
   b. TIA/EIA-4720000-A: Generic Specification for Fiber Optic Cable;
   c. United States Department of Agriculture (USDA) Rural Electrification Administration (REA) PE-90: REA Specification for Filled Fiber Optic Cables (updated per Bulletin 1753F-601 on August 4, 1994); and appropriate sectional specifications.
5. Fiber optic cable: free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.
6. The fiber cable contains a water-blocking material in a loose tube construction with up to 12 buffer tubes wrapped around a dielectric central strength member. All fiber(s) are contained within buffer tubes, and each buffer tube has an inside diameter much greater than the total diameter of the fiber(s) it supports.
7. Each fiber or group of fibers freefloats within the tubes such that all mechanically or environmentally induced stress placed upon the cable is decoupled from the fibers. Air within the buffer tubes is displaced by the water-blocking material to prevent entry by water and to facilitate free movement of the fiber(s) within.
8. Buffer tubes: color coded in compliance with TIA/EIA598, Color Coding of Fiber Optic Cables. Cables constructed of more than six fibers may have several fibers occupying a buffer tube, with equal distribution of fibers as far as feasible. Color code all fiber to comply with TIA/EIA598.

9. Each buffer tube of the cable contains water-blocking material to prevent entry of water.
    a. Water blocker: provided between the cable jacket and the outside of the buffer tubes.
    b. Binder wrapping strength member of aramid fibers: provided as a final layer prior to application of the outer jacket.
10. Outer jacket:
    a. Constructed of medium density polyethylene.
    b. Minimum thickness: 1.4 mm.
    c. Applied directly over the tensile strength members and water blocking means.
    d. Outer jacket is UV and fungus resistant.
11. Outer jacket labeling:
    a. The date of manufacture and the manufacturer's name.
    b. A numerical sequence, at intervals no greater than 3 m, to determine the length of cable and amount of cable remaining on the reel.
    c. "Utah Department of Transportation Fiber Optic Cable" at an interval of no greater than 3 m.
    d. Height of the markings is 2.5 mm nominal.
12. All optical fibers are 100 percent attenuation tested at the factory for compliance with performance specifications described in this section. The attenuation results of each fiber are provided with each cable reel.
13. All fiber cable is suitable for installation in underground conduit or lashed to messenger cable, and meets or exceeds the following specifications:
    a. Operational Wavelength: 1310 nm and 1550 nm.
    b. Optical Attenuation: at 1310 nm: 0.4 dB/km at 20 C at 1550 nm: 0.25 dB/km at 20 C.
    c. Optical Dispersion: at 1310 nm: $\leq$ 4.5 psec/nm-km at 1550 nm: # 20 psec/nm-kmZero.
    d. Dispersion Wavelength:1300 to 1320 nm, nominal.
    e. Zero Dispersion Slope: # 0.092 ps/nm^2-km.
    f. Fiber Core Diameter: 8.3 Fm, typical.
    g. Fiber Coating Diameter: 250 +/- 10 mm.
    h. Fiber Cladding Diameter: 125 +/- 1 mm.
    i. Core to Cladding Offset: # 0.8 mm.
    j. Cladding NonCircularity: # 1.0 percent.
    k. Spot Size: 9.3 +/-0.5 mm at 1310 nm.
       10.5 +/-1 mm at 1550 nm.
    l. Cutoff Wavelength: # 1250 nm.
    m. Crush Resistance: 5000 N/m, length of cable.

n. Cable Outside Diameter: 13mm, maximum.
o. Minimum Bending Radius:
Installation: 20 times cable outside diameter.
Static: 10 times cable outside diameter.
p. Operating Temperature:
Installation: -30 C to +70 C.
Storage/Operation: - 40 C to +70 C.
q. Humidity: 0 to 100 percent.
r. Tensile Strength:
Installation: 2700 N.
Static: 600 N.

14. The cable is waterproof, complying with water penetration test conducted in accordance with EIA/TIA-455-82-B for fluid blocking fiber optic cable.

15. Fiber optic drop cables:
a. With the number of fiber strands and connectors as shown on the plans.
b. Terminated with ST or ST compatible connectors, installed using factory approved procedures.
c. With connectors for all fiber strands that have present usage.
d. Drop cable fan out kits: heavy duty Spider design.
e. Buffer tubes: protected by the cable sheath or fan out kit. Exposed buffer tubes are not acceptable.
f. Individual fiber strands: protected by 2.9mm kevlar tubes.
g. Minimum tubing length is 610 mm.

E. Factory Test
1. Fibers Tested: Each strand.
2. Light Frequency: 1310 nm and 1550 nm.
3. Direction: unidirectional.
4. Location: Cable Factory.
5. When Performed: Tested prior to shipment.
6. Tested by: Factory Staff.
7. Cable meets factory attenuation specifications.
a. Cable attenuation # 0.4 dB/km at 1310 nm.
b. Cable attenuation # 0.25 dB/km at 1550 nm.
c. Strand lengths are consistent.
d. Launch Transition < 6 dB.
e. No event > 0.30 dB.
8. Traces will be available for each strand in cable.

2.3 FIELD FIBER OPTIC DATA MODEM (DEPARTMENT FURNISHED ITEM)

A. Designed to support full duplex asynchronous RS232 communications in a multidrop counter rotating ring, daisy chain, and twoheaded daisy chain topology.

B. Configurable as master submaster or local units and meeting the following specifications:
   1. Optical Loss Range: 0 - 17 dB.
   2. RS-232 Data Rate: DC to 100 kbaud.
   3. Operating Wavelength: 1310 nm.
   4. Fiber Type: Single Mode.
   5. Pilot Tone Frequency: 430 to 450 khz.
   6. Power Supply: External Transformer 120 VAC Primary, 8 to 18 VDC secondary.
   7. Operating Temperature: -37 C to +75 C.
   8. Humidity: 0 to 98%.
   9. Optical Connector: ST.
   10. Data Connector: DB25 F.
   11. LED Indicators: TD1, RD1, TD2, RD2, Power, Fault.
   12. AntiStreaming Timeout: User Selectable 4, 8, 16, 32, or 64 seconds or disabled.
   13. Fault Output: Dry contact closure.
   14. Compatibility: optically and electrically operate with Force Model 2869 in the same circuit.
   15. Package: Shelf Mount 150 mm x 150 mm x 30 mm maximum.

2.4 FIBER OPTIC CONNECTORS

A. With the following characteristics:
   1. Factory installed or field installed ST or ST compatible connectors.
   2. Ceramic ferrules and metallic connector bodies.
   3. Maximum insertion loss: 0.50 dB. Maximum insertion loss of 1.0 dB is acceptable with approval of the Engineer.
   4. Connector back reflection: greater than 35 dB.

B. Clean all connectors with alcohol wipes and a compressed cleaning gas.

C. Furnish and install new spider fan-out kits, to replace any existing fan-out kits that must be severed in order to make ST connections. Replace fan-out kits in kind.

2.5 CLOSET CONNECTOR MODULE

A. Required in existing closet connection housings and hub shelters entered by fiber optic cables.

B. Characteristics:
1. Six fibers per module.
2. Six ST connectors.
3. Six strand factory made single mode pigtail.
4. Height equivalent to four rack units high.
5. Mate with Siecor existing CCH-04U closet connector housing.
6. Siecor CCH-CM06-61 or equivalent.

2.6 STAND ALONE VIDEO OPTICAL TRANSMITTER

A. Physical Characteristics
1. Maximum Size: 200 mm x 120 mm x 38 mm.
2. Maximum Weight: 1 kg.
3. Mounting Holes: 4 minimum.
4. Package: High quality aluminum, complete enclosure.
5. Indicators: LED type, neatly labeled and visible from mounted position.
6. User Settings: No user adjustments or settings.

B. Electrical Characteristics
1. Application: Single Fiber Uni-Directional RS-250C Medium Haul Video Transmitter with bi-directional RS-232 data.
2. Modulation: Frequency Modulation or digital encoding.
3. Data Connector: DB 9 F.
4. Data Rate: up to 19.2 kbps, suitable for bursty data.
5. Bit Error Rate: 10-9 minimum over full optical range.
6. Video Connector BNC.
7. Power Consumption: 1-Watt maximum.
8. Video Signal to Noise: 50-dB minimum unweighted over full optical range.

C. Optical Characteristics
1. Physical: ST Type Connector.
2. Optical Range: 18 dB for Single Mode Fiber, 13 dB for multi-mode fiber.
3. Operating Wavelength: 1310 nm.
4. Backreflection: Tolerance of -35 dB.
5. Reliability: Laser Mean Time Between Failure 500,000 hours.

D. Compatibility: directly interchangeable.

2.7 RACK MOUNT VIDEO OPTICAL RECEIVER

A. Physical Characteristics
   1. Maximum Size: 200 mm by 120 mm by 38 mm.
   2. Maximum Weight: 1 kg.
   3. Mounting: Sliding Rack Mount Card with retainers.
   4. Package: High quality aluminum, complete enclosure, compatible with rack mounting chassis.
   5. Indicators: LED type, neatly labeled and visible from mounted position.
   6. User Settings: No user adjustments or settings.

B. Electrical Characteristics
   1. Application: Single Fiber Uni-Directional RS-250C Medium Haul Video Receiver with bi-directional RS-232 data.
   2. Modulation: Frequency Modulation or digital encoding.
   3. Data Connector: DB 9 F.
   4. Data Rate: up to 19.2 kbps, suitable for bursty data.
   5. Bit Error Rate: 10-9 minimum over full optical range.
   6. Video Connector BNC.
   7. Power Consumption: 1-Watt maximum.
   8. Video Signal to Noise: 50-dB minimum unweighted over full optical range.

C. Optical Characteristics
   1. Physical: ST Type Connector.
   2. Optical Range:18 dB for Single mode fiber, 13 dB for multi-mode fiber.
   3. Operating Wavelength:1310 nm.
   4. Backreflection:Tolerance of –35 dB.
   5. Reliability: Laser Mean Time Between Failure 500,000 hours.

D. Compatibility: directly interchangeable.

2.8 RACK MOUNT CHASSIS

A. Width: Suitable for mounting in EIA Standard 19 inch rack.

B. Height: Not to Exceed 4 Rack Units.

C. Depth: Not to Exceed 300 mm.

D. Capacity: Ten Rack Mount Video Optical Receivers.

E. Engineering:
1. Designed to retain ten rack mount cards and provide clear view of indicators and labels on cards.
2. Designed to provide easy access to all optical and electrical connectors.

F. Power Supply:
1. Suitable for powering ten rack mount video optical receivers.
2. UL listed.
3. Equipped with overcurrent protection, power on indicator lamp, and power on/off switch.

G. Line Cord: 1.8 m IEC Standard.

H. Input Voltage: 90 to 135 VAC.

I. Input Frequency: 47 to 63 Hz.

J. Output Ripple: 120-mV peak to peak maximum.

K. Output Voltage: Compatible with rack mount video optical receivers over full input voltage range.

2.9 RS-232 SIGNAL DISTRIBUTION UNIT

A. General
1. Unit feeds data from one RS-232 input communication port to ten RS-232 serial output data communication ports.
2. Provide looping input for additional signal distribution units.
3. Compatible with all system components.
4. One LED indicator per channel.
5. Maximum Size:200 mm by 65 mm by 140 mm.

B. Environmental
1.. Temperature Range: 10 degrees C to 40 degrees C.
2. Humidity: 0-90 percent non condensing.
3. Weight: Less than 3 kg.

C. Power
1. Input Voltage: Unregulated 15V dc, 800mA.

2. Transformer: 110V ac, 25 watts.

D. Data Communications
1. Data Signal Connectors: DB-9 mating, provided.
2. Data Signal Cable: Belden 8102 or equivalent.
3. Transmission Distance: Up to 300 m at 9600 Baud.
4. Characteristics: 1 RS-232 input with pass through.
5. RS-232 Outputs: 10.

E. Provide standard metal rack mount shelf with unit for installation in existing EIA Standard 19 inch rack.

2.10 TYPE A AND B FIBER OPTIC CABLE SPLICE ENCLOSURE

A. Type A: For locations with more than 48 splices.
1. 150 mm diameter by 560 mm long.
2. One three section (six entry) end plate.
3. One blank end plate.
4. Two or more 36 fiber count fusion splice trays.
5. All required accessories to complete the splice.
6. End plates are suitable for use with Coyote closures.

B. Type B: For locations with up to 48 splices.
1. 150 mm diameter by 430 mm long.
2. One three section (six entry) end plate.
3. One blank end plate.
4. Four 12 fiber count fusion splice trays.
5. All required accessories to complete the splice.
6. End plates are suitable for use with Coyote Pup closures.

C. General Requirements
1. Capable of handling up to six cables in butt configuration without special adapters.
2. Nonfilled (no encapsulate), to prevent water infusion.
3. UL rated.
4. External Shrader valve pressurization port.
5. Able to reenter and reassemble without special tools.
6. Contain mountings for splice organizer assemblies.
7. Contain space for excess or un-spliced cable.
8. Provide one future cable entry kit with each splice closure.

9. Meet Telcordia Technologies/Bellcore Testing Requirements GR771CORE.
10. Corrosion resistant aluminum and stainless steel hardware.
11. Suitable for straight, butt, or branch splices.
12. Packaged with all hardware necessary for completion of splice.
13. Provisions for strain relief around the cable jacket and internal cable strength members.
14. Enclosure accepts loose tube fiber optic cables.
15. Enclosure accepts up to six cable entries in a butt splice configuration and twelve cables for an inline configuration.
16. Enclosure has a permanent neoprene gasket seal.
17. Enclosure is re-enterable without special reentry kits.
18. Enclosure has premolded three section end plates with six cable entries.
19. End plates are interchangeable with each size of closure available from the closure supplier.
20. All closures, with captive closing hardware, are from the same supplier.
21. Provide glassfilled highdensity thermoplastic enclosure shells that effectively withstand corrosion, high impact and freezethaw stresses.
22. Use torque bars to secure, support and align end plates.
23. Provide enclosure with rubber tape for sealing around cables to provide a seal that compensates for expansion and contraction associated with temperature cycling.

2.11 SPLICE ENCLOSURE END PLATE

A. Replace existing plates at splice enclosures that are modified.

B. Suitable for use with Coyote Pup closures.

C. Three section (six entry) end plate.

2.12 FIBER OPTIC JUMPER

A. Single mode fiber.

B. 2.9 mm Kevlar outer jacket.

C. ST connector required on each end.

D. Determine length based on physical distance of run. Minimum length: 2 m.

2.13 JUMPER STORAGE PANEL

A. 2 rack units high.

B. 480 mm wide.

C. Designed for routing of fiber optic jumpers.

D. Matte black finish.

E. Siecor CSP-02U or equivalent.

F. Furnished with cover, mounting hardware, grommets and installation manual.

2.14 RS-422/RS-232 CONVERTER

A. Converts RS-422 data between the CCTV assembly and the video optical transceiver.

B. General
1. Transmits data at distances up to 1000 m.
2. Operate in multipoint applications.
3. 2 or 4-wire operation.
4. Speeds up to 115.2 kbps.
5. Auto-transmitter enable: baud rates up to 64 kbps.
6. Selectable half-duplex turnaround delay.
7. Selectable RTS-CTS turnaround delay.
8. Echo suppression.
9. Bias enable.
10. Terminate/Reconnect option.
11. Externally selectable loop-back test feature.
12. Operation: 4 wire, half or full-duplex, 2-wire, half-duplex.
13. CE Approval: Yes.
14. Connectors: (1) DB25 F; (1) 4-screw terminal.
15. Power: 115 VAC, 60 Hz.
16. Max Size: 220 mm by 150 mm by 50 mm.
17. Max Weight: 0.5 kg.
18. Mean time before failure: 200,000 hours.

C. Environmental
1. Operating Humidity: 0 to 95 percent non-condensing.

2. Operating Temperature: 0 to 50 degrees C.
3. Storage Temperature: -20 to 70 degrees C.

D. Interface A:
1. RS-232 DTE/DCE selectable.
2. Connectors: DB25 Female.
3. Data Rate: Data rate is transparent up to 115 kbps.
4. Distance: Standard EIA specifications apply.
5. Leads: 2 thru 8 and 20.

E. Interface B:
1. RS-232 or RS-485.
2. Connectors: 4 position screw down terminal strip.
3. Data Rate: Transparent.
4. Distance: 1200 m based on 24 AWG UTP low capacitance cable.
5. Leads: TX+, TX-, RX+, RX-.

2.15 FIBER OPTIC SPLITTER

A. Splits the signal from a fiber optic video transmitter to two different destinations, with the following characteristics:
1. Compatible with single mode fiber.
2. 50:50 split of video signal, or weighted ratio as specified.
3. Maximum dB loss of 3.6 dB.
4. ST connectors.

2.16 COMMUNICATION SHELTERS

A. Provide prefabricated controlled environmental shelters with an alarm system for remote monitoring.

B. Construction:
1. Materials: Solid concrete with steel rebar reinforcement. Solid heavy duty steel doors and locks. Reinforcing Steel ASTM A615-85, Grade 60.
2. Structure: No seams below ground level. Minimum concrete compressive strength: 34.5 MPa at 28 days.
3. Design Load: meet or exceed State of Utah Building Codes.
4. Interior Dimensions: 3.5 m wide by 5 m long by 3 m high.
5. Interior Area: 17.5 sq. m^2, 52.5 m^3.
6. Door Opening: 1.5 m wide x 2 m high.

C. Environmental
   1. Air Conditioning: 30,000 BTU HVAC system.
   2. Heater: 10 kW.
   3. Lighting: Interior 4 dual tube fluorescent fixtures, 40W lamps. Exterior 100W incandescent lamp.

D. Electrical
   1. 120/240 volts, single phase, 100 amps with 10 branch circuits.
   2. 100 amp generator input connector.
   3. Auto alarm system for high temp, smoke, power loss, and intrusion.
   4. Alarm terminal block.
   5. Interior copper ground bar assembly with two through wall ground sleeves.
   6. 4 hour timer switch for lighting.

E. Mechanical
   1. In floor cable entry opening.
   2. Magnetic door switch with alarm.
   3. Electro-mechanical environmental control panel with manual override.
   4. Automatic high limit override.
   5. Wall mounted CO2 fire extinguisher.

PART 3 EXECUTION

3.1 INSTALLERS

A. Complete a three-day course on the installation, splicing and testing of fiber optic cable.
   1. Course: conducted by the supplier of the fiber optic product or established education provider.
   2. In house and on the job training is not acceptable.

B. Demonstrate two years total and one year continuous work experience with the splicing, termination, and testing of fiber optic cable.

C. Perform all work with qualified staff.

3.2 FIBER OPTIC CABLE INSTALLATION REQUIREMENTS

A. Notify the Engineer 48 hours in advance of fiber optic cable installation into any existing conduit or building facility.

B. The Engineer will initiate special inspection procedures to verify the condition of existing communications facilities. Such inspection may be observed by the Contractor.

C. Perform all work in facilities (e.g. conduits, junction boxes, cabinets and buildings) containing Department's existing communications equipment only in the presence of Department's representative.

D. Restore Contractor damaged facilities within 48 hours.

E. Lubricate cable with a lubricant designed for fiber optic cable installation.

F. Use shear pins or other failsafe means to prevent exceeding the maximum cable pulling tension specified by the cable manufacturer.

G. Maintain the following minimum bend radiuses:
1. 20 times Cable Diameter: Short Term During Installation.
2. 10 times Cable Diameter: Long Term Installed.

H. Maintain the following slack requirements:
1. Vaults: 20 m.
2. All Junction Boxes: 10 m.
3. Cabinets: 5 m.

I. Replace any fiber optic cable segment not meeting the requirements of the specifications in its entirety between splice points shown on the plans.

J. Place the locator wire in the dedicated 19 mm conduit as shown in the plan details.

3.3 FIBER OPTIC CABLE PREPARATION

A. Remove the jacket without damaging buffer tubes.

B. Carefully expose the fibers by removing the buffer tube with a special tool.

C. Clean the fibers and buffer tubes using a solvent designed to remove all water blocking gel from each exposed fiber.

D. Solvent requirements:
1. Must not remove any color from individual fibers or buffer tubes.

2. Not harmful to the polyethylene cable jacket.

E. Cleave fiber strands using a cleave tool meeting the following requirements:

1. Ability to cut the individual fibers as close to a perfect 90 degree angle as possible.
2. With minimum end angle averages that are less than 0.70 degree with no cuts exceeding 1.5 degrees.

3.4 ENTRY AND REENTRY OF FIBER OPTIC SPLICE CLOSURES

A. Perform all work in a suitable environment free from excess dust and moisture. Acceptable environments to work on splice closures include office type environments in buildings, splice trailers, and splicing tents with floors.

B. Do not perform fiber splicing, testing, or connecting in freezing temperatures.

C. Do not expose open splice closures and fiber ends to rain, snow, or wind-blown dust.

3.5 FUSION SPLICING

A. All fiber splicing: fusion splice method.

B. Connectors: factory made connector and pigtail or drop cable assemblies.

C. Field polishing of connectors: Not acceptable.

D. Perform fusion splices with the following:
1. Equipment with automatic fiber alignment and automatic light injection with detection devices or profile alignment algorithms to estimate splice losses.
2. Provide splice closure as a protection for all splices and stripped cable.
3. House all splices in splice trays or organizers.
4. Use glass capillaries, heat shrink tubing, or silicone sealant to provide additional protection and strain relief.
5. Maximum splice loss allowance is 0.20 dB.

E. Install new splice enclosure end plates at each location where there is a new fusion splice in an existing splice enclosure per manufacturer's recommendations.

3.6 FIELD QUALITY CONTROL TESTING

A. Receiving Test
   1. Fibers Tested: Normally, one strand per buffer tube. Test every strand when evidence of physical damage exists or when any damaged strand is found.
   2. Light Frequency: 1310 nm and 1550 nm.
   3. Direction: Unidirectional.
   4. Location of test: Contractor's yard.
   5. Test after receiving material, before releasing to installation crew.
   6. Tested by: Qualified Contractor Staff.
   7. Cable meets factory attenuation specifications.
      a. Cable attenuation # 0.4 dB/km at 1310 nm.
      b. Cable attenuation # 0.25 dB/km at 1550 nm.
      c. Strand lengths are consistent.
      d. Launch Transition < 6 dB.
      e. No event > 0.30 dB.
   8. Trace available for one strand in every buffer tube in the cable.

B. Post Blowing/Pulling - Pre Splicing Test
   1. Fibers Tested: Normally, one strand per buffer tube. Test every strand when evidence of physical damage, excessive pulling tension, kinks exists, or when any damaged strand is found.
   2. Light Frequency: 1310 nm and 1550 nm.
   3. Direction: Unidirectional.
   4. Location of test: One field location for each cable installed.
   5. Test after installing cable in duct but before splicing.
   6. Tested by: Qualified Contractor Staff.
   7. Witnessed/Approved by: Department inspector may witness and must approve before splicing.
   8. Acceptance Criteria:
      a. Cable attenuation # 0.4 dB/km at 1310 nm.
      b. Cable attenuation # 0.25 dB/km at 1550 nm.
      c. Strand lengths are consistent.
      d. Launch Transition < 6 dB.
      e. No event > 0.30 dB.
   9. Trace available for one strand in every buffer tube in the cable.

3.7 CABLE LABELING REQUIREMENTS

A. Label all fiber optic cables with a high quality permanent label, indicating the street name or location and type of circuit (drop cable, distribution, backbone-96 count).

B. Use Panduit MP-150-C or equivalent.

3.8 INSTALLATION OF HUB FIBER EQUIPMENT

A. Install all Hub equipment in accordance with the plans and the equipment manufacturer's recommendations.
   1. Provide all mounting hardware and incidental materials, including fasteners, shelves, and brackets.
   2. Provide surge protected power strips as needed for all equipment installed in buildings.

B. To gain access to the ATMS Hub, contact the Engineer at least ten working days prior to the time access is needed.

C. The Department may elect to have personnel present in Hub during any activity.

D. Install RS-232 Signal Distribution Unit securely on new shelf on existing rack at location indicated in plans.

E. Install Rack Mount Video Optical Transceivers in rack mount chassis on existing rack at location indicated in plans.

3.9 INSTALL FIELD FIBER COMMUNICATION EQUIPMENT

A. Install field communication equipment in existing signal cabinets as shown in the plans.
   1. Equipment includes stand alone video optical transmitters, field fiber optic data modems, and RS-422/RS-232 converters.
   2. Install equipment in accordance with the equipment manufacturer’s recommendations, including mounting, interconnection wiring, electrical service, all mounting hardware and incidental materials, including fasteners and brackets.
   3. Provide all surge protected power strips for all equipment installed.
   4. Install equipment on existing shelf space in cabinets.

ATMS Fiber Optic Continuity Test Form						
Light Source Location	**Channel**	**Source to Strand Number**	**Power Meter Location**	**Meter to Strand Number**	**Power Meter Reading (dBm)**	**On/Off (yes or no)**

END OF SECTION